



Armed Forces College of Medicine

AFCM



Biochemical basis Obesity & weight regulation

By

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Intended Learning

Outcomes

- 1. Interpret the biochemical basis of body weight regulation**
- 2. Enumerate the causes of obesity**
- 3. Outline effect of obesity**



Case scenario



A 49 -year- old married woman, 158 cm tall and weighting 108 Kg came for consultation to a physician complaining of increased weight. She was too worried about her weight gain.

- She has **sedentary life style**. Her dietary habits revealed **high caloric diet** and absent consumption of vegetables and fruits



Endocrine & Genitourinary Module•



During routine physical examination



the patient was observed to be hypertensive (blood pressure of 200/120 mm Hg).

- The patient was asked to return to the clinic during fasting state and blood specimen was obtained.
- Lab investigation revealed:



Normal range

mg/dl 70

mlU/L 20

mg/dl 120

150mg/dl >

What is the most likely diagnosis?

obesity

mg/dl 280

mg/dl 177

Parameter

glucose fasting

Total cholesterol

Triglycerides

What is Obesity?



Definition:

Obesity is a disorder of body weight regulatory systems characterized by an accumulation of excess body fat (increase fat cells size and number) either generalized or localized



WHO classified the weight according to body mass index (BMI) into:

Body Mass Index - (Kg/m²)

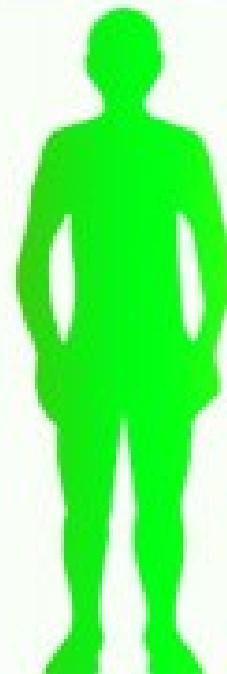
Below 18.5

Underweight



18.5 to 24.9

Normal



25 to 29.9

Overweight



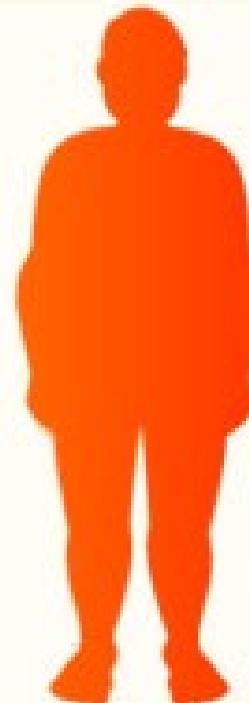
30 to 34.9

Obese class I



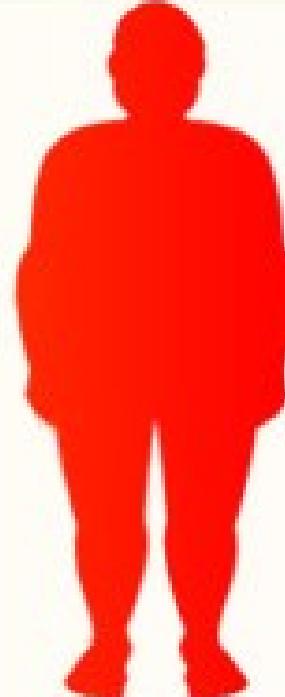
35 to 40

Obese class II



Above 40

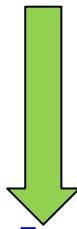
Obese class III



Regulation of body weight

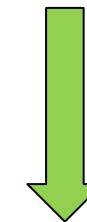


Long term signals
(Hormones)



- 1- Leptin (satiety hormone)**
- 2- Insulin**

short term signals
(minutes to hours)



1-GIT hormones

- **Hunger: Ghrelin**
- **After meal: CCK, PYY**

2-Neural signals

3-Hypothalamic



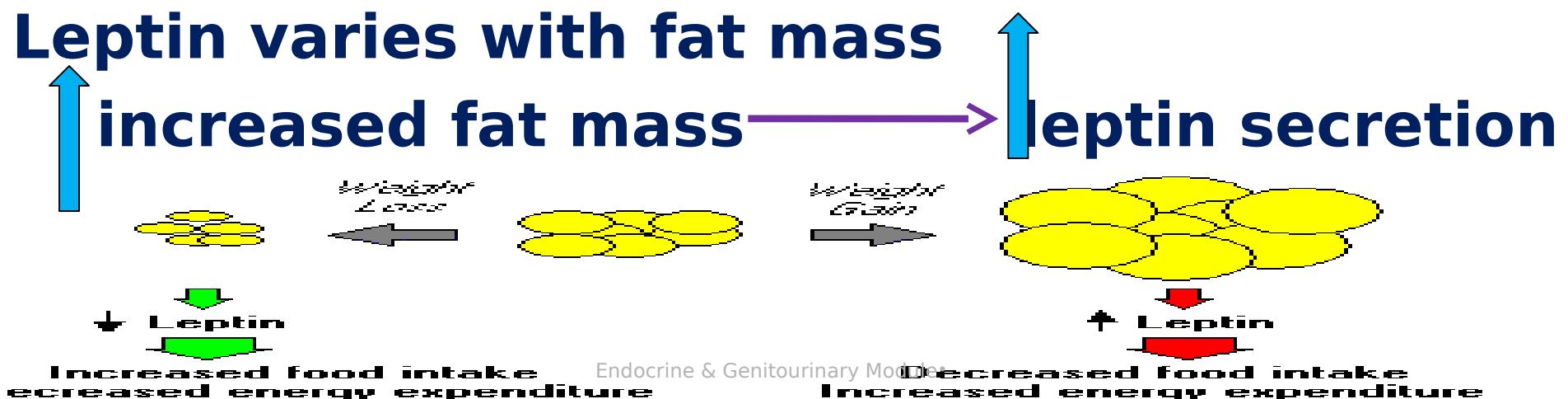
1- Leptin (satiety hormone)



- Site of synthesis:

- Leptin is a **hormone secreted mainly from white adipose tissue.**
- Can be produced in **very small amount** by placenta, skeletal muscle, stomach ,liver, bone marrow, and mammary glands.
- **Eating (meal) → stimulate leptin secretion**

- Blood level:



1- Leptin (satiety hormone)



- **Function:**
- **Increase energy expenditure (loss)**
- **It considered a satiety hormone through:**

A. Directly:

Stimulate **satiety center**
appetite).

(stop eating & Decrease



B. Indirectly:

I. **Leptin can increase the sensitivity of hypothalamic satiety center to Cholecystokinin (CCK) leads to satiety**

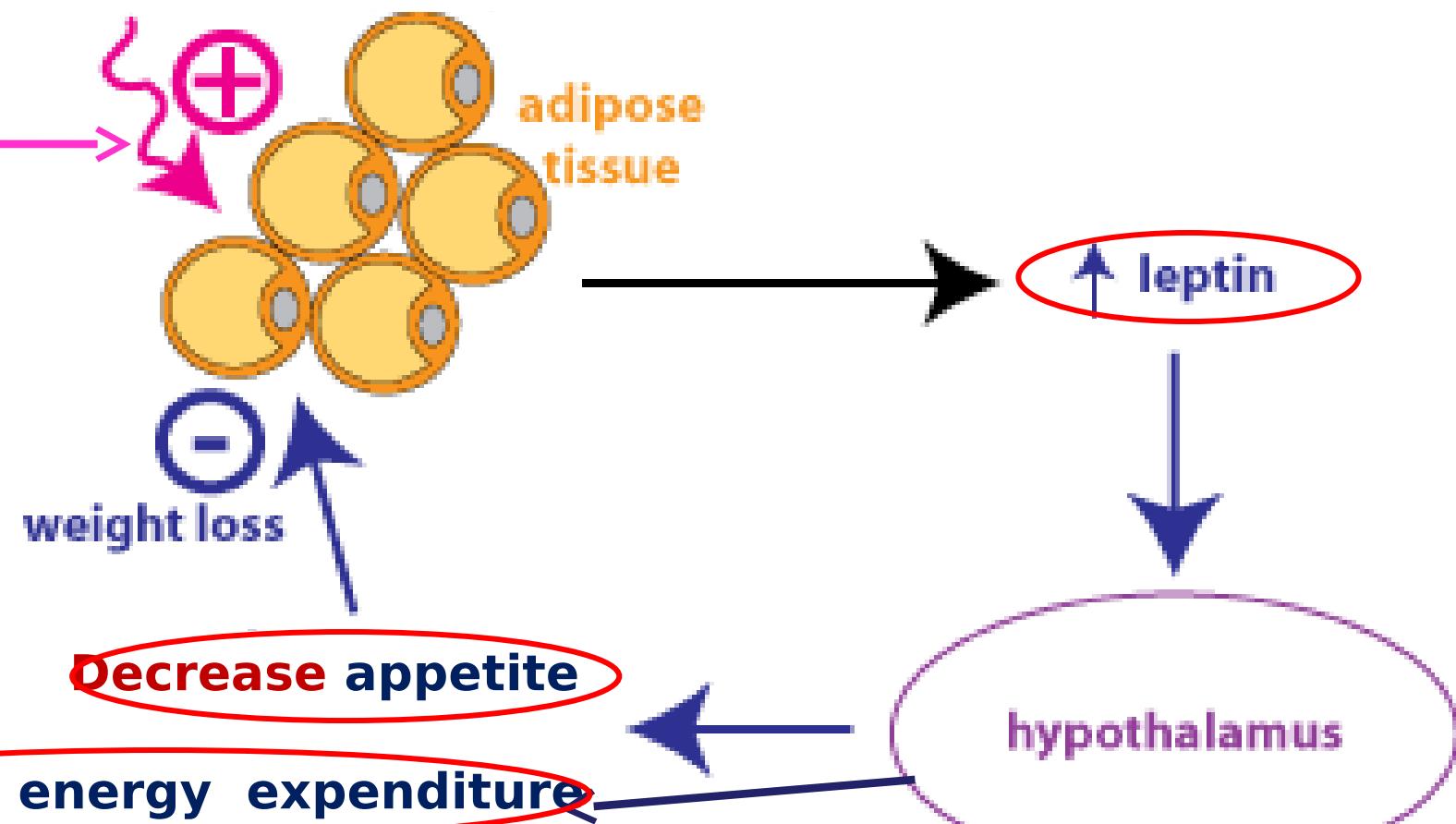
II. **Leptin can decrease the sensitivity of hypothalamic hunger center no hunger sensation**



1- Leptin (satiety hormone)



Food intake (eating)



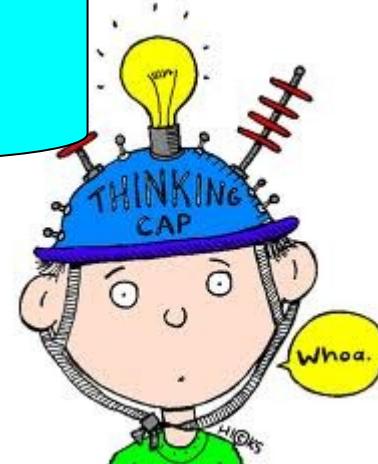
What about Leptin levels in obesity?



1. Why leptin levels increased in obese person?

Due to increased body fat mass in obese person

But there is resistance to this leptin



Insulin -2

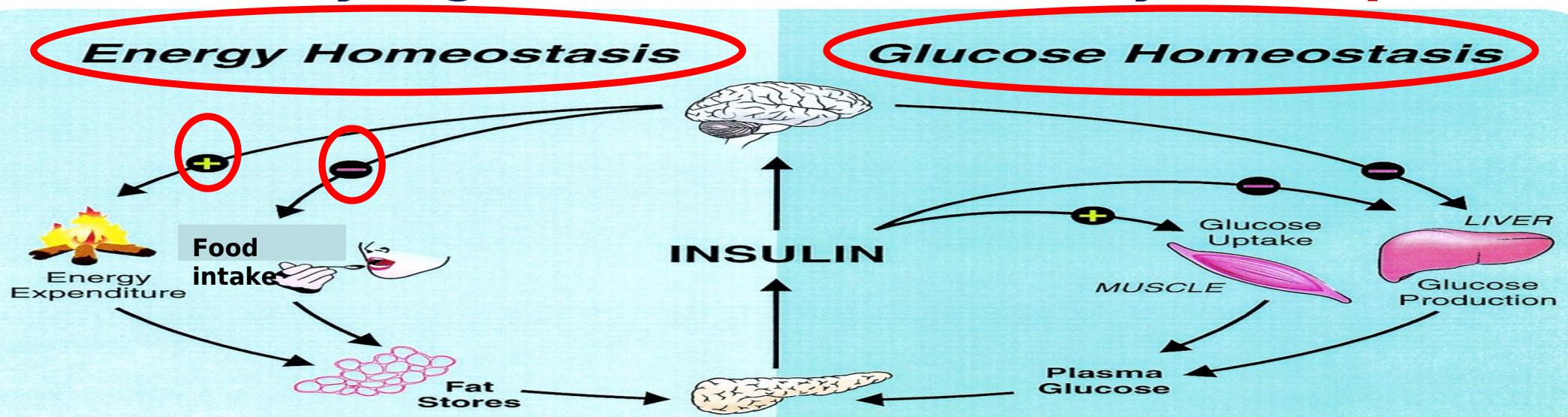


- Insulin hormone secreted by β cells of pancreas
- A meal (eating) \uparrow blood glucose level stimulate

insulin secretion which leads to:

1-Decrease food intake :

through **increased sensitivity of satiety center**
to satiety signals feel of satiety stop



B. Short-term signals (minutes to hours)



- Short-term signals from the gastrointestinal tract control hunger and satiety.
- They affect the size and number of meals



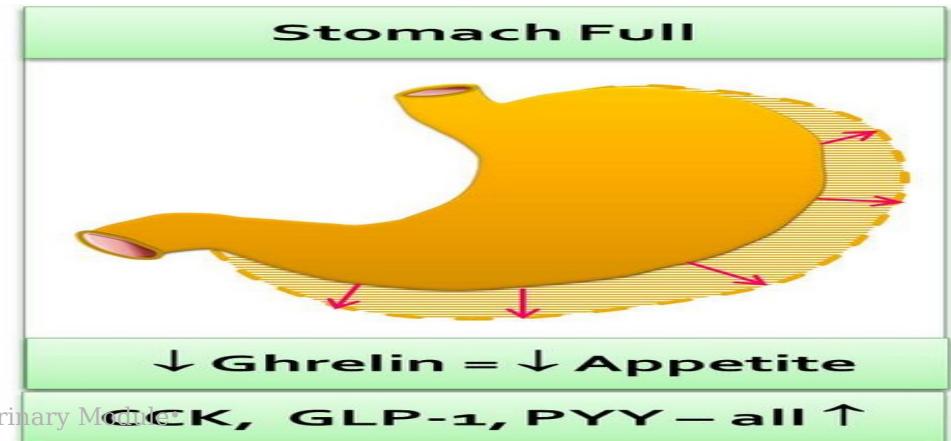
A) In the absence of food intake (between meals)

1. Ghrelin (appetite-stimulating) "hunger hormone"

Source:

produced by ghrelinergic cells in the gastrointestinal tract

• Function



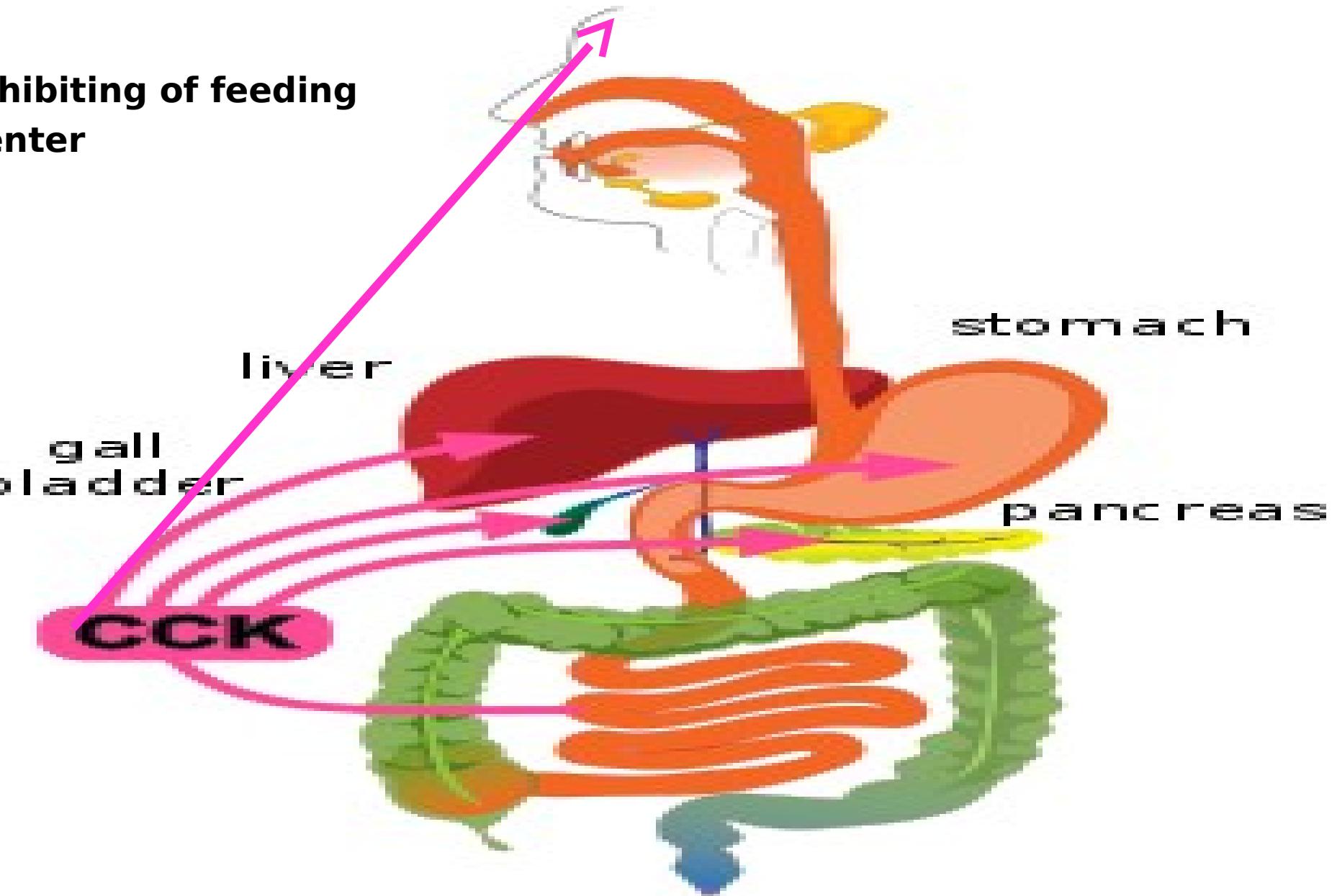
B) After meal





- Cholecystokinin (CCK from Greek *chole*, "bile"; *cysto*, "sac"; *kinin*, "move").
- **Source:**
Is synthesized by enteroendocrine cells in the duodenum.
- It is released rapidly into circulation in response to a meal.
- **Function:**
 - Inhibiting of feeding center (stop eating)
 - Delay gastric emptying → give chance for digestion
 - Contraction of gall bladder → release of bile which help in digestion
 - Stimulate release of pancreatic enzyme in the small intestine.

Inhibiting of feeding center



Peptide YY (PYY)-2



➤ Source:

It is a peptide released from ileum and colon in response to feeding.

➤ Action :

- Inhibiting of feeding center
- Delay gastric emptying → give chance for digestion

neural signals-2

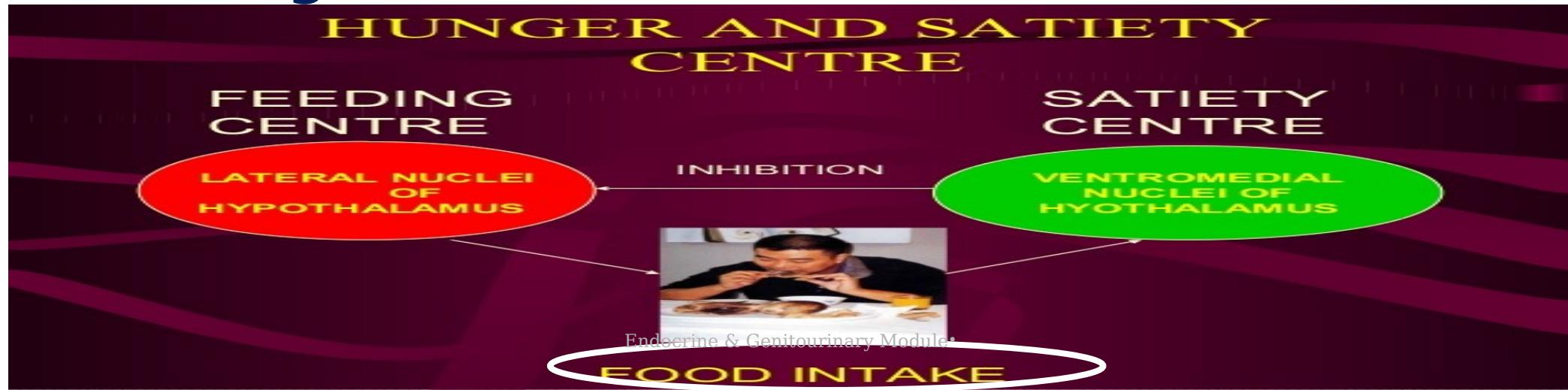


- Mechanical:

Stomach felling by food (stretch) \rightarrow
neural signals transmitted by vagi nerves
to the hypothalamus cause:

Stimulation of satiety center

Inhibition of feeding center \rightarrow stop
eating



hypothalamus-3



The hypothalamus secrete neuropeptides such as:

i. Hormone:

Alpha melanocyte stimulating hormone (α -MSH): inhibit feeding sensation **satiety**
—————→

i. Neurotransmitters:

such as serotonin and dopamine are important in regulating hunger and satiety.

Adipose tissue as endocrine



-Adipose tissue is now known **organ** to play an active role in body weight regulatory systems.

Adipose tissue is an endocrine cell that secretes a number of adipocytokine which act as hormones such as:

1-Leptin “satiety hormone”



2-

Adiponectin-2



- **Site of synthesis:**

produced in mainly from adipose tissue.

Physical exercise (activity) stimulate adiponectin secretion

- **Function**

- Reduces levels of blood free fatty acids.
- Improved lipid profile
 - Increase HDL cholesterol
 - Decrease LDL cholesterol
 - Decrease triglycerides
- Increase insulin sensitivity
 - better glycemic control and blood glucose level
- Anti-inflammatory
 - Reduce inflammation

Causes of obesity



1-Lack of energy balance :

A lack of energy balance most often causes overweight and obesity . Energy balance means that **energy IN** equals **energy OUT** .

2-An inactive sedentary life





energy expenditure
through metabolism and
physical activity



energy intake
from food
and drink

3-Environmental factors :

- Lack of sidewalk
- Oversized food portions
- fast foods
- Decreased consumption of healthy foods .



4-Genes and family history

Obesity has genetic basis??

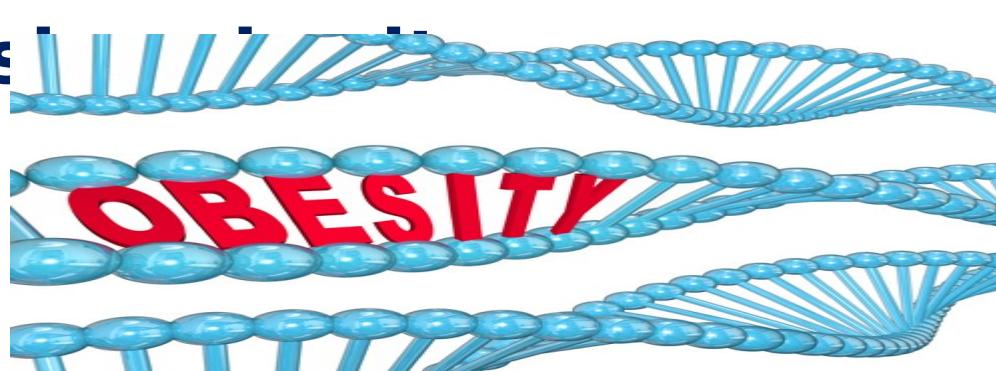
➤ Identical twins have very similar body mass index (BMI) than those of non identical twins.

➤ **Gene Mutations :**

For example :some genetic mutation associated with :

- Hyperphagia

- Mass



5-Hormonal disturbances :

- Hypothyroidism
- Cushing syndrome
- Polycystic ovarian syndrome .



6-Medicines :

- Corticosteroids
- Antidepressant
- Antiepileptic



7-Emotional factors :

Some people eat more when they are bored, angry or stressed.



Normal



Cushing's

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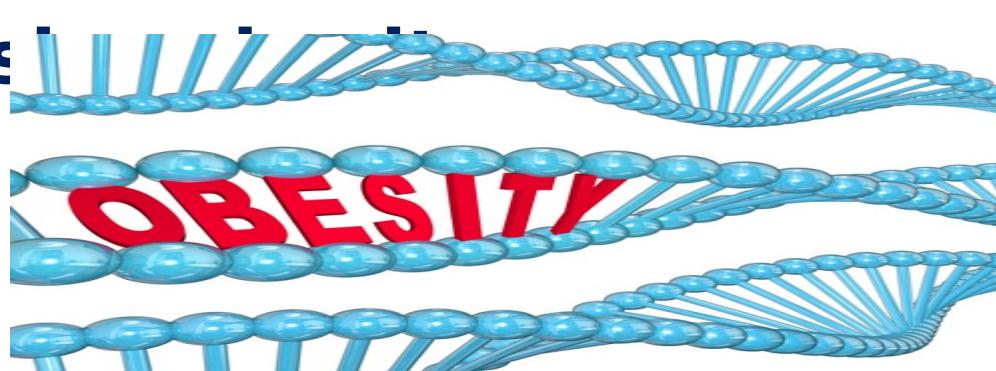
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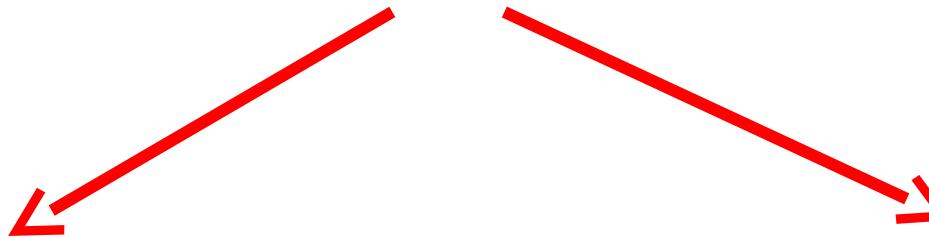


Cushing's



Effect of obesity

Metabolic changes associated problems



health associated

- 1- Metabolic syndrome
- 2- other health associated problems

Dyslipidemias

- High total cholesterol level
- High LDL- cholesterol level
- Low HDL- cholesterol level
- High triglycerides level

2. Insulin resistance

3. Pre diabetes (impaired glucose tolerance)

? What health problems associated with obesity?

Obesity leads to increased risk of developing associated diseases, such as:

- **Arthritis.**
- **Metabolic syndrome**
- **Hypertension,**
- **Cardiovascular disease**
- **Cancer.**
- **Fatty liver.**
- **Depression**
- **Gallbladder diseases**
- **Diabetes**
- **Atherosclerosis**



Definition

A cluster of metabolic abnormalities associated with Abdominal obesity (central obesity)

Includes

- **Hyperglycemia**
- **Insulin resistance**
- **Dyslipidemia: (Increased total cholesterol level and/or LDL-cholesterol and/or decreased HDL-cholesterol and/or increased triglycerides levels).**
- **Hypertension**

Lecture Quiz



**Which one of the following hormones
increase insulin sensitivity?**

- A. Leptin**
- B. Adiponectin**
- C. Gherlin**
- D. CCK**

Lecture Quiz



Which one of the following hormones is hunger hormone?

- A.Leptin**
- B.Adiponectin**
- C.Gherlin**
- D.CCK**

Calculate:

Calculate the BMI for a patient ,the weight of this patient was 85.5 Kg and the height was 155 cm.

Answer:

1. Firstly convert the height to meters:

$$155 \text{ cm} = 1.55 \text{ m}$$

2. $\text{BMI} = \text{weight (kg)}/\text{height (m}^2\text{)} = 85.5/(1.55)^2 = 35.6 \text{ kg/m}^2$.

SUGGESTED TEXTBOOKS



- **"Lippincott's Illustrated Reviews in Biochemistry" by P.C.Champe, R.A.Harvey and D.R.Ferrier**
- **"Harper's Biochemistry" by R.K.Murray, D.K.Granner, P.A. Mayes and V.W.Rodwell.**
- **Fundamentals of Clinical Chemistry (Tietz) Sixth**
- **"Textbook of Biochemistry with Clinical Correlations" by T.M.Devlin**
- [www.namrata.co-](http://www.namrata.co/) **Biochemistry for medics**
- **Mahan LK, Escott-Stump S, Raymond JL, Krause MV. Krause's food & the nutrition care process. Elsevier Health Sciences; 2017.**

Helpful Websites

- **World Health Organization**
<http://www.who.int/topics/obesity/en>
- **Calculate your BMI**
<http://www.nhlbisupport.com/bmi/bminojs.htm>
- **Nutrition Facts**
<http://www.nutritiondata.com>



thank you

Dr. Amal El-Shal